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ly 18 miles per day, and after 9 days turns and goes back as far as B has traveled during those 9 days; he then turns again, and, pursuing his journey, overtakes B $22\frac{1}{2}$ days after the time they first set out. It is required to find the rate at which B uniformly traveled. [From *Greenleaf's Arithmetic.*]

Solution by J. F. TRAVIS, Student in the Ohio State University, Columbus, Ohio.

Let $\frac{x}{2}$=number of miles B traveled per day. Then

$22\frac{1}{2}\times\frac{x}{2}$=total distance B traveled.

$18\times9=162$=number of miles traveled by A in 9 days, and

$162-9\times\frac{x}{2}$=number of miles A is from starting point.

$(9\times\frac{x}{2})\div18=\frac{x}{2}\div2$=number of days A traveled backwards.

$\therefore$ $9+\frac{x}{2}\div2$=total number of days A traveled.

$22\frac{1}{2}-(9+\frac{x}{2}\div2)=13\frac{1}{2}-\frac{x}{2}\div2$=number of days in which A must overtake B.

To overtake B, A must travel $[22\frac{1}{2}\times\frac{x}{2}-(162-9\times\frac{x}{2})]\div18$ days.

$\therefore$ $[22\frac{1}{2}\times\frac{x}{2}-(162-9\times\frac{x}{2})]\div18=13\frac{1}{2}-\frac{x}{2}\div2$, from which we find $\frac{x}{2}=10$= number of days.

This problem was also solved by *F. R. HONEY*, *G. B. M. ZERR*, and *M. A. GRUBER*. Mr. Gruber gave an alegebraic solution and discussed the problem in general.

88. Proposed by J. A. CALDERHEAD, M. Sc., Professor of Mathematics, Curry University, Pittsburg, Pa.

Find the principal of a note given March 19, 1891, bearing interest 6%. Payments: September 1, 1892, \$243.50; January 19, 1893, \$6.90; April 13, 1894, \$19.10; September 19, 1894, \$110.90. Amount due February 22, 1897, \$229.10.

Solution by COOPER D. SCHMITT, A. M., Professor of Mathematics. University of Tennessee, Knoxville, Tenn.; P. S. BERG, B. Sc., Superintendent of Schools, Larimore, N. D., and NELSON L. RORAY, Professor of Mathematics, South Jersey Institute, Bridgeton, N. J.

The amount \$229.10 due February 22, 1897, has been running 2 years, 5 months, 3 days. Hence the principal is easily found to be \$200.

The payments of \$6.90 and \$19.10 are evidently less than the interest.

Hence the \$200 has been running since September 1st, 1892, or 2 years, 18 days. But the payments \$6.90, \$19.10 and \$110.90 must be added to the \$200, making \$336.90.

Working back we find that this on September 1st, 1892, was \$300. But \$243.50 was paid on this date; hence we have \$543.50 as principal and interest which has been running since March 19, 1891, or 1 year, 5 months, 12 days.

Whence amount=\$543.50. Rate=6%. Time=1 year, 5 months, 12 days, and hence principal is easily found to be \$500.

Also solved by *G. B. M. ZERR.*

89. Proposed by NELSON L. RORAY, South Jersey Institute, Bridgeton, N. J.

Solve by pure arithmetic. A criminal having escaped from prison traveled 10 hours before his escape was known; he was then pursued so as to be gained upon 3 miles an hour: after his pursuers had traveled 8 hours they met an express going at same rate as themselves, who had met the criminal 2 hours and 24 minutes before; in what time from the commencement of the pursuit will they overtake him?

Solution by M. A. GRUBER, A. M., War Department, Washington, D. C.; MARTIN SPINX, Wilmington, O.; F. R. HONEY, Ph. B., New Haven, Conn.; ALBERT J. GIBBS, Salida, Col.; and AMELIA BACH, Salida, Col.

When the pursuers met the express they had been in pursuit 8 hours. When the express met the criminal, the pursuers had been following the criminal $8-2\frac{2}{5}=5\frac{3}{5}$ hours, and the criminal had been escaping for $10+5\frac{3}{5}=15\frac{3}{5}$ hours.

As the express and the pursuers traveled at the same rate, the distance traveled by the criminal in $15\frac{3}{5}$ hours was traveled by the pursuers in $8+2\frac{2}{5}=10\frac{2}{5}$ hours. The pursuers, in this time, gained $10\frac{2}{5}\times 3=31\frac{1}{5}$ miles. This distance was evidently traveled by the criminal in $15\frac{3}{5}-10\frac{2}{5}=5\frac{1}{5}$ hours.

$\therefore$ The criminal's rate of travel was $31\frac{1}{5}\div 5\frac{1}{5}=6$ miles per hour.

The crimiual therefore had the start of $10\times 6=60$ miles.

But the pursuers gained 3 miles per hour. Then, to gain 1 mile they had to travel $\frac{1}{3}$ hour, and to gain the 60 miles they had to travel $60\times\frac{1}{3}=20$ hours= the time required.

Also solved by *J. H. DRUMMOND, WILL RYAN, D. G. DORRANCE, Jr., W. H. DRANE, G. B. M. ZERR, FREMONT CRANE, M. E. GRABER, B. F. YANNEY*, and *J. A. MOORE.*

ALGEBRA.

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81. Proposed by JOHN M. COLAW, A. M., Monterey, Va.

Show that
$$\frac{a_1^r}{(a_1-a_2)(a_1-a_3)(a_1-a_4)\dots(a_1-a_n)}$$
$$+\frac{a_2^r}{(a_2-a_1)(a_2-a_3)\dots(a_2-a_n)}+\dots\frac{a_n^r}{(a_n-a_1)(a_n-a_2)\dots(a_n-a_{n-1})}$$

is zero if r is less than $n-1$; to 1 if $r=n-1$, and to $a_1+a_2+a_3+\dots a_n$ if $r=n$.

[*C. Smith's Treatise on Algebra*, Ex. 53, page 104.]

Solution by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi, University, Miss.

The fractions being reduced to their least common denominator, every term of the numerator contains the factor a_1-a_2 except the first and the second. If, in the numerator, we put $a_1=a_2$, the first two terms become the same with opposite signs and each of the remaining terms has a zero-factor. Hence the numerator vanishes under this supposition, and, therefore, a_1-a_2 is a factor of it. Similarly every factor of the denominator may be shown to be a factor of the numerator. Now the latter is a homogeneous expression of a degree less than that of the denominator by $n-1-r$, there being $n-1$ factors in the denominator of each of the original fractions.

If $r<n-1$, the numerator is of lower degree than the denominator. But, as proved above, there are as many conditions that cause the numerator to vanish as there are factors in the denominator. In this case the number of these is greater than the degree of the numerator, which is, therefore, identically equal to zero.